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**IMO / FAO / UNESCO / WMO / WHO / IAEA / UN / UNEP  
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS  
OF MARINE POLLUTION  
- GESAMP -**

# **REPORTS AND STUDIES**

**No. 18**

Report of the thirteenth session  
Geneva, 28 February - 4 March 1983



**WORLD HEALTH ORGANIZATION**



IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP  
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS  
OF MARINE POLLUTION  
- GESAMP -

REPORT OF THE THIRTEENTH SESSION

Geneva, 28 February - 4 March 1983



WORLD HEALTH ORGANIZATION 1983

Notes

1. GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMO, FAO, UNESCO, WMO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice on marine pollution problems to the Sponsoring Agencies and to the Intergovernmental Oceanographic Commission (IOC).
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Definition of Marine Pollution by GESAMP

"POLLUTION MEANS THE INTRODUCTION BY MAN, DIRECTLY OR INDIRECTLY, OF SUBSTANCES OF ENERGY INTO THE MARINE ENVIRONMENT (INCLUDING ESTUARIES) RESULTING IN SUCH DELETERIOUS EFFECTS AS HARM TO LIVING RESOURCES, HAZARDS TO HUMAN HEALTH, HINDRANCE TO MARINE ACTIVITIES INCLUDING FISHING, IMPAIRMENT OF QUALITY FOR USE OF SEA WATER AND REDUCTION OF AMENITIES."

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1. OPENING OF THE MEETING

- 1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its thirteenth session at WHO Headquarters, Geneva, from 28 February to 4 March 1983, under the Chairmanship of Mr A.D. McIntyre. Mr E.D. Gomez was Vice-Chairman.
- 1.2 In welcoming the participants on behalf of the Director-General of WHO, Mr B.H. Dieterich, Director of the Division of Environmental Health commended GESAMP for its important technical and scientific contribution to the work of the United Nations system in the marine environmental field. Referring to the respect with which the work of GESAMP is regarded by the international community, Mr Dieterich expressed appreciation for the time and efforts contributed by GESAMP experts and stated that the success of GESAMP also reflected well on the interagency co-operation necessary for the provision of secretariat functions. The interdisciplinary nature of GESAMP makes this group an outstanding body within the UN system where all sectoral concerns on the marine environment are meeting. Mention was made of a number of matters presently being dealt with by GESAMP which are of concern to WHO, the review of potentially harmful substances being of particular interest. WHO was also grateful for the recent publication of the GESAMP Reports and Studies No. 15 on the Review of the Health of the Oceans. In conclusion Mr Dieterich wished GESAMP every success in its tasks and re-emphasized the importance of GESAMP's technical role.
- 1.3 The Chairman of GESAMP, through Mr Dieterich, thanked the Director-General of WHO on behalf of the participants for the good wishes for the success of the session, for hosting the meeting and for the provision of secretariat facilities. He also introduced the new members of the Group.
- 1.4 The agenda for the session as adopted by the Group is given in Annex I. A list of documents submitted to the session, including information papers relating to the activities of the sponsoring organizations and substantive papers relating to particular items of the agenda is given in Annex II.
- 1.5 A list of participants is given in Annex III. Upon learning of the ill-health which had prevented the attendance of Mr R.P. Chesselet the Group sent a cable to Mr Chesselet offering their best wishes for a speedy recovery and an early return to good health.

2. REVIEW OF THE HEALTH OF THE OCEANS

- 2.1 The Chairman of GESAMP opened the discussion of this agenda item by referring to the terms of reference of GESAMP which indicate that a task of the Group should be to prepare assessments of the state of the health of the oceans.
- 2.2 The Unesco Technical Secretary reminded the Group that, upon the request of GESAMP at its twelfth session, a Steering Committee, constituted from the GESAMP Working Group on the Review of the Health of the Oceans, was charged with preparing an annotated outline of the envisaged structure of the next review. It was further recommended that information on how this task was to be accomplished should be supplied. It was reported that the Steering Committee met twice during the intersessional period and prepared a brief report to GESAMP XIII for consideration.
- 2.3 Mr G.E.B. Kullenberg was invited to present the report prepared by the Steering Committee. He described the contents of the report which followed the structure recommended by GESAMP XII. Accordingly part A of the report consisted of an annotated outline describing the contents of the envisaged chapters required to produce a future Review of the Health of the Oceans. Part B described the contents in more detail and Part C provided information on the methodology suggested to accomplish the task. Mr Kullenberg invited the Group for its comments from two different viewpoints:

- (i) the scientific aspects contained within the document (their relevance, omissions, etc.) and the tasks to be accomplished;
  - (ii) organizational aspects.
- 2.4 After extensive discussion the Chairman recommended that the small Steering Committee receives assistance from some additional experts to assess the document and prepare a revised draft for consideration at a later stage of the session. It had been frequently indicated by the members of GESAMP that future exercises should not repeat the procedures of the previous review and that the focus should be placed on addressing aspects of marine pollution requiring attention. The sub-group duly modified the original report so as to focus on the priority areas.
- 2.5 The report of the sub-group was introduced by Mr Kullenberg who pointed out that a priority list of topics had been drawn up indicating which existing working groups could be allocated tasks and those areas where new working groups may be considered. In this connexion it was recommended that a new working group should be formed to investigate the transport and fluxes of selected substances in the marine environment covering the land/sea and sea/sediment interfaces with the terms of reference as contained in paragraph 10.1 of this report. The Technical Secretary of Unesco offered his agency to act as lead agency of such a working group. It was further recommended that matters related to the exchange across the air/sea interface could be addressed by the existing working group on this topic. The investigation of trends and changes was identified to be a priority topic which could receive inputs from all working groups including the newly proposed Working Group on Methodology and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment (see paragraph 10.7). This working group may also undertake the development of assessment methodology and dose/response considerations.
- 2.6 The report of the sub-group was accepted on the understanding that the appropriate corrections would be made. It appears as Annex IV.
3. OCEANOGRAPHIC MODEL FOR THE DISPERSION OF WASTES DISPOSED OF IN THE DEEP SEA
- 3.1 The Working Group met three times during the intersessional period: (i) 23-27 November 1981 in Monaco; (ii) 3-7 May 1982 in Halifax, Nova Scotia; and (iii) 22-26 November 1982 in Vienna at IAEA Headquarters. The IAEA Technical Secretary expressed her appreciation for the efforts of the Working Group and noted that the IAEA was prepared to publish the appendices as an integral part of the report.
- 3.2 The Chairman of the Working Group presented the report which is summarized in Annex V. He pointed out that the report was sent for review to 37 individuals in summer 1982. Eighteen substantial replies were received which were taken into account at the final meeting of the Working Group.
- 3.3 The Chairman of GESAMP complimented the Working Group on the report and noted that the appendices did seem to be an integral part of the report. The Group was requested to comment on the report.
- 3.4 Specific points raised during the discussion of the report were resolved by the Chairman of the Working Group with their initiators during the session. The hope was expressed that many agencies would find the report useful. The report was approved by the Group for publication as GESAMP Reports and Studies No. 19, subject to the correction of details discussed.



#### 4. REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

- 4.1 The report on the intersessional activities of the Working Group was introduced by its Chairman, a summary is attached as Annex VI. A planning meeting had been held 24-25 September 1982 in Stockholm and the first session of the Working Group from 31 January to 4 February 1983 at WHO, Geneva. The support provided by the co-sponsoring agencies, WHO, FAO and UNEP, was appreciated by the Working Group.
- 4.2 The deliberations of the Working Group were initially based on data profiles which were provided by UNEP's International Register of Potentially Toxic Chemicals (IRPTC). WHO's environmental health criteria documents and other published reviews were used when assessing potential hazards. Conclusions were prepared by the Working Group with regard to harm to living resources and hazards to human health. Dietary intake assessment and estimates of seafood consumption appeared to be crucial in evaluating human health risks.
- 4.3 During the next intersessional period the evaluation of the first three substances should be completed, namely cadmium, lead and tin. The next group would include mercury, arsenic and organosilicons. The latter was included initially due to international legal implications rather than acute concern about their harmfulness. IRPTC data profiles for organosilicons were made available during the session.
- 4.4 The Group was particularly concerned about the evaluation of the organosilicons as this group of compounds is rather large with some reactive and some persistent members. Available data coverage may also not correspond to the evaluation needs of the Working Group. It was agreed, therefore, to undertake informally a preliminary review of the IRPTC data profile and identify those compounds which could possibly be included in the review by the Working Group. Furthermore, reports were available with IMO concerning the position of organosilicons in major international conventions.
- 4.5 In general, evaluation of potential human health hazards is largely dependent on reliable estimates of seafood consumption patterns, including marine food products from aquaculture. The Group confirmed the appropriateness of the Working Group's intention to explore the availability of relevant data from various international sources and documented case studies.
- 4.6 The revised draft reports on cadmium, lead and tin will be circulated to all GESAMP members for comments before the drafts will be finalized at the second session of the Working Group in late 1983. The Group also endorsed the time schedule of the Working Group and the first six substances chosen. As concerns the other substances proposed during GESAMP XII, a decision on their evaluation will be taken at GESAMP XIV. IRPTC is already preparing data profiles on these substances to assist in the selection process.

#### 5. EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

- 5.1 The IMO Technical Secretary informed the Group that the Working Group had held one meeting from 25 to 29 October 1982 in Delft. He indicated that the requirements for the prevention and control of marine pollution by noxious liquid substances carried in bulk (MARPOL 73/78, Annex II) will enter into force in October 1986, and will have to be amended immediately thereafter due to developments in the carriage of bulk chemicals since adoption of the convention in 1973. The majority of the subject matter covered by these amendments will be based on the results of GESAMP's work related to the evaluation of the hazards of harmful substances carried by ships. It was pointed out that relevant IMO bodies had agreed that a complete set of draft amendments be finalized by the end of 1984.

- 5.2 The Chairman of the Working Group informed the Group of the response to the query made by GESAMP at its twelfth session regarding carcinogenic properties of substances in relation to marine biota and the use of the Ames test. The Group noted that the Working Group had confirmed its attitude that it would only identify those substances when there is clear evidence that they are human carcinogens or when there is little doubt as to their carcinogenic properties in mammals including man. Mutagenicity studies, particularly in respect of appropriately chosen batteries of such tests will only be used as supporting evidence in the assessment of a carcinogenic potential.
- 5.3 With regard to a request of GESAMP XII that the Working Group take into account problems that could arise with regard to the low degradability of substances in cold climates, it was noted that the criteria for the categorization of pollutants set out in MARPOL 73/78 referred in particular to the high biochemical oxygen demand (BOD) of certain substances and the consequent problems of low dissolved oxygen concentrations, rather than to the low biodegradability of substances under certain conditions. The Chairman of the Working Group emphasized that, when evaluating the hazards of substances, the various environmental conditions were duly taken into account.
- 5.4 The Group took note of the difficulties encountered by the Working Group regarding the lack of data, in particular on the aquatic toxicity of substances proposed for maritime transport in bulk, and that much of the information submitted through IMO to the Working Group was not referenced with regard to its source. The group confirmed the view of the Working Group that any data on environmental effects (aquatic, mammalian and human toxicity) set out in submissions to IMO should be accompanied by descriptions of testings made and/or references to data sources. The IMO Technical Secretary was requested to draw the attention of the relevant IMO bodies to this necessity.
- 5.5 The Group welcomed the information that steps of co-operation between the Working Group and UNEP's IRPTC have been taken.
- 5.6 The Group took note of the consideration of the Working Group on the question of using standard methodology for the assessment of tainting ratings. In the absence of a standard methodology for the assessment of tainting and of reliable literature data on this criteria for many substances, it was realized that these ratings so far have been highly subjective. The Group confirmed that the Working Group should use hard data for its assessment, such as the concentrations that give rise to tainting in a particular species. The Group agreed with the steps taken so far by the Working Group towards the identification of appropriate tainting methodologies.
- 5.7 The Group approved the report of the Working Group including the hazard profiles of substances listed in the annex to the report. A summary of the Working Group report is set out in Annex VII.
- 5.8 The Group agreed that the Working Group should continue with its task. In view of the need to achieve certain objectives by the date established by IMO (see paragraph 5.1) the lead agency of the Working Group was requested to investigate the possibilities of arranging several meetings of the Working Group during the next intersessional period. The Group, noting that the present Chairman of the Working Group will be unable to participate in future sessions of the Working Group, expressed its thanks for the work he had accomplished.
6. INTERCHANGE OF POLLUTANTS BETWEEN THE ATMOSPHERE AND THE OCEANS
- 6.1 The Chairman of the Working Group introduced the report of the fourth session which was held from 25 to 29 October 1982 in Monte Carlo. A summary report is contained in Annex VIII. This session was devoted primarily to matters relating to research and monitoring of land-based pollutant transport via the atmosphere to specific marine

regions, and to the development of an action plan for a meeting of experts to address this problem in the Mediterranean region. The Working Group also reconsidered and approved the report of its ad hoc meeting held in 1981 in Tallin. It was stated that the Working Group would reformulate the reports of the ad hoc meeting and its third and fourth session into a format suitable for publication in the GESAMP Reports and Studies series.

- 6.2 The Group noted that some points in the report of the fourth session of the Working Group require clarification. There was a discussion of the possible selection of mercury instead of the recommended substance, cadmium, as a model pollutant to test the analytical and modelling system. It was pointed out that mercury studies in the Mediterranean are complicated by inputs from natural sources. In addition, this substance has both a vapour and particulate component in the atmosphere. This complicates collection and analysis and is one reason why it was not selected as the first test pollutant.
- 6.3 The Chairman noted that the Working Group was to co-operate with the newly proposed Working Group on the Land-Sea Boundary Flux of Pollutants (see paragraph 10.1). Also, the Working Group will consider the atmospheric transport of pollutants into the region of the Kuwait Action Plan, as well as into the Mediterranean region.
- 6.4 To accommodate these new tasks, the following terms of reference for the Working Group were adopted by the Group:
- (i) to describe transport processes towards and into specific regions, using the Mediterranean as the first example, and the region of the Kuwait Action Plan as a possible second example, including:
    - horizontal atmospheric transport affecting the region;
    - vertical atmospheric transport to the air-water interface;
    - air-water interchange;
  - (ii) to review the scientific literature and assess the pathways and fluxes of important pollutants into particular regions, using the Mediterranean as the first example, and the region of the Kuwait Action Plan as a possible second example, and to differentiate between natural and pollutant sources;
  - (iii) to provide a review of air-sea material interchange with emphasis on:
    - (a) the pollutant modification of ocean-related processes, especially those pertinent to climate;
    - (b) the air-water interfacial exchange of CO<sub>2</sub>, O<sub>2</sub> and organosulfur compounds and of pollutants such as organohalogen compounds.
- 6.5 The Group noted that these revised terms of reference involved a considerable extension of those used before. The Group agreed, however, that this extension was not undesirable as it would allow consideration of a number of potentially important matters. The Group stressed that in relation to the new item (iii)(b) in the terms of reference emphasis should in the first instance be placed upon consideration of the possible interference by pollutants accumulated in the surface microlayer with the exchange of oxygen and carbon dioxide across the air-sea interface. In addition, particular attention should be paid to fossil fuel sources, especially coal, in the pilot study developed for cadmium.
7. BIOLOGICAL EFFECTS OF THERMAL DISCHARGES IN THE MARINE ENVIRONMENT
- 7.1 The FAO Technical Secretary informed the Group that the Working Group had held its second session in Rome from 18 to 22 October 1982. The Chairman of the Working Group introduced the report, a summary of which is given in Annex IX.

- 7.2 The Chairman of the Working Group explained that developing guidelines for the siting of discharges of heated waters was an ambitious task in view of the wide variety in engineering design and practices, in regulations and laws in different countries and, last but not least, in ecosystems at locations where power generations or major industrial processing plants are planned. Keeping in mind the needs of countries which may have few resources or little experience or in-house expertise in producing environmental impact assessments of thermal effluents, the Working Group decided to concentrate on providing a framework of rules and criteria that could be of general application, and to devise guidelines for a minimal monitoring programme.
- 7.3 The Group noted that the Working Group had up-dated and amended the review of information on the effects of thermal discharges in coastal waters, part of the report already presented to GESAMP XII. In addition, the Working Group had concentrated on its second term of reference, to develop guidelines for the siting of discharges of heated waters with a view to minimizing harmful effects on living marine resources. It was noted that additional expertise, particularly in the fields of economics, engineering and land use planning was needed to complete that part of the report. In addition, several points were discussed in detail by the Group which will result in some changes and amendments to the report. Main subjects of discussion were the effects of seawater fluegas washing, the fate of chlorine in the marine environment, the possible occurrence of fish diseases related to thermal discharges, and the proposed phased programme of investigation and assessment of impacts of power plants.
- 7.4 The Group endorsed the report of the Working Group and recommended that it holds a third session with partly changed membership to accommodate additional expertise in cost/benefit methodologies, power plant engineering, and land-use planning, and that it presents its final report for approval at the fourteenth session of GESAMP.
8. REVIEW OF THE GESAMP DEFINITION OF "MARINE POLLUTION"
- 8.1 The Group at its twelfth session had taken note of a proposal submitted by the WMO to amend the definition of marine pollution by the addition of the phrase "and altering ocean-related physical processes including climate". The Chairman introduced a summary of the various views expressed on this matter and invited the Group to take appropriate action.
- 8.2 The WMO Technical Secretary informed the Group that the Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans at its fourth session discussed the WMO proposal (see paragraph 6.1). The majority of the Working Group suggested the addition of the following wording to the marine pollution definition: "and altering ocean-related physical processes especially pertinent to climate".
- 8.3 The Group took note that anthropogenic activities affecting the physical properties of the sea surface might be one of a number of factors which could change climate. In this connexion the Group also considered pollutant modification of physical and chemical processes at the air-sea interface, in particular capillary wave attenuation, gas transport reduction, surface temperature and light transmission. The Group also noted that recent analyses indicate that petroleum films do not modify the global exchange of matter or energy significantly. However, in certain coastal areas and seas, especially along shipping routes, such films are more prevalent and could have local effects.
- 8.4 The Group also noted that the existing definition had stood the test of time and been widely used and incorporated in various legal texts, and that it includes in its explicit formulation only deleterious effects. It nevertheless does not rule out consideration of additional aspects and there is no need to produce an exhaustive list of effects.

8.5 The Group agreed to keep the definition as it stands but asked the Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans to prepare an explanatory statement on process modification by pollutants for consideration at the fourteenth session of GESAMP.

9. MARINE POLLUTION IMPLICATIONS OF OCEAN ENERGY DEVELOPMENT

9.1 The UN Technical Secretary informed the Group that the Working Group had held its second meeting at FAO, Rome, from 25 to 29 October 1982 and produced a report which covered four sources of ocean energy which could be viable by the year 2000. These include ocean thermal energy conversion (OTEC), wave energy, tidal energy and marine biomass.

9.2 He noted the continued importance of the need to provide advice to developing countries on the environmental effects of ocean energy and their multiple use as well as on the studies needed to make impact assessments.

9.3 The report of the Working Group was introduced by its Chairman who reviewed its scope and the terms of reference which were set out by GESAMP XI. The sources of ocean energy examined were those expected to be significant in the near future. Because of its relevance to energy needs of developing countries the early dissemination of the information in this report was considered important.

9.4 The Group received the report but noted that relevant data were lacking and few serious studies were available for reference. In particular the impact of OTEC upwelling on primary productivity and climate requires further study as does the coastal impacts of wave energy application.

9.5 The report was amended to take discussions and comments into account. After these amendments, the Group agreed on a procedure for approving the report of the Working Group for publication in the GESAMP Reports and Studies as No.20. It was also understood that the Chairman of the Working Group would make further editorial improvements and prepare a list of selected references to be included in the report. The final draft would then be circulated to all GESAMP members who would comment to the Chairman of GESAMP if they see any objection to its publication. A summary of the report and its table of contents are given in Annex X.

10. FUTURE WORK PROGRAMME

(i) Land-sea boundary flux

10.1 In response to a request of the Steering Committee on the Review of the Health of the Oceans (see paragraph 2.5) the Group agreed to establish a new Working Group on the Land-Sea Boundary Flux of Pollutants with the following terms of reference:

(i) to review the scientific literature and assess the sources, pathways and fate of selected substances across the land-sea boundary to allow for a quantitative description of the flux of material to and through the marine environment;

(ii) to describe the processes which control the fate of material being introduced into the estuarine and marine environment, with initial emphasis being given to the near shore and exchanges with the open ocean;

(iii) to consider and/or stimulate limited case studies to demonstrate the applicability and accuracy of the models generated;

(iv) to develop a report that can be used as input to total mass balance models and the next Review of the Health of the Oceans.

(ii) Assessment of the impact of pollutants on the marine environment

- 10.2 The Group then considered a request submitted by the UNEP Technical Secretary for the formulation of guidelines for the assessment of the waste receiving capacity of the marine environment and of the environmental impact of pollution on marine and coastal environments (document GESAMP XIII/10). This request referred to action plans being developed or implemented in ten regional sea areas under the UNEP Regional Seas Programme and to the need for relevant technical guidelines. As a result, UNEP would welcome the establishment by GESAMP of a working group to formulate such guidelines.
- 10.3 Some members of the Group expressed concern about the use of the term "receiving capacity" which might be interpreted as meaning that it endorses the use of the ocean as a general repository of all forms of wastes. In addition, there was concern that the concept of receiving capacity would not be applicable for assessing the hazards of all substances.
- 10.4 The Technical Secretaries of IMO, FAO, Unesco, WMO, WHO, and the IAEA expressed the general support of their organizations for the ideas underlying the UNEP proposal but several indicated that, bearing in mind that the proposal had been tabled for the first time at the current session, they were not in a position to respond formally to the proposal. The IMO Technical Secretary stated that the formulation of guidelines as proposed could be of relevance to some current considerations of the Scientific Group of the London Dumping Convention, especially in regard to the application of Annexes II and III to the Convention.
- 10.5 The observer of the IOC pointed out that some aspects of the assessment guidelines required by UNEP had already been covered by previous GESAMP working groups and that repetition of previous work of the Group should be avoided.
- 10.6 In the discussion a number of views were expressed both on the concepts underlying the proposal and upon the magnitude of the task. The consensus of this discussion was that, providing the terms of reference could be narrowed down to certain achievable goals, the Group should respond positively by setting up a working group.
- 10.7 The Group agreed to establish a new Working Group on the Methodology and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment with the following terms of reference:
- (i) to analyse and define factors relevant to the determination of the impact of wastes on the marine environment, taking into account effects on marine organisms and ecosystems, human health and amenities:
  - (ii) to develop and evaluate the concepts on which the assessment of the impact of wastes introduced into the marine environment should be based, including the concept of assimilative capacity of the marine environment, and to analyse and recommend the required methodologies.
- (iii) Other intersessional work
- 10.8 Following the above decisions on the establishment of two new working groups, the Group noted that intersessional work would take place on the subjects listed below. The sponsoring organizations responsible for coordinating the intersessional work and the GESAMP members assigned to each working group are indicated. Additional members from outside GESAMP are selected by the Chairmen in consultation with the relevant organizations.

(a) Review of Potentially Harmful Substances

Lead Agency : WHO  
Co-operating Agencies : FAO and UNEP  
Chairman : L. Friberg  
Members : A.B. Jernelöv  
L.P.A. Magos

(b) Evaluation of the Hazards of Harmful Substances Carried by Ships

Lead Agency : IMO  
Co-operating Agency : UNEP  
Chairman : P.G. Jeffery  
Members : -

(c) Biological Effects of Thermal Discharges in the Marine Environment

Lead Agency : FAO  
Co-operating Agencies : Unesco and UNEP  
Chairman : G.D. Howells  
Members : E.P. Myers  
V. Pravdic

(d) Interchange of Pollutants between the Atmosphere and the Oceans

Lead Agency : WMO  
Co-operating Agencies : UNEP and IAEA  
Chairman : W.D. Garrett  
Members : R. Fukai  
V. Koropalov  
V. Pravdic

(e) Land-Sea Boundary Flux of Pollutants

Lead Agency : Unesco  
Co-operating Agencies : IAEA and UNEP\*  
Chairman : H. Windom  
Member : G.T. Needler

(f) Methodology and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment

Lead Agencies : FAO and WHO  
Co-operating Agencies : IMO, Unesco\* IAEA\* and UNEP  
Chairman : V. Pravdic  
Members : E.D. Gomez  
E.P. Myers  
J.E. Portmann

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\* Subject to approval by Headquarters

11. DATE AND PLACE OF NEXT SESSION

- 11.1 The Group noted that the fourteenth session of GESAMP would be held at IAEA Headquarters in Vienna, from 26 to 30 March 1984. It was agreed that the deadline for distribution to GESAMP members of documents for consideration at that session shall be 31 January 1984.

12. OTHER MATTERS

- 12.1 The problems associated with the reliability of data available for the assessment of marine pollution situations were brought to the attention of the Group. The Chairman of the Working Group on the Review of Potentially Harmful Substances reported on efforts undertaken to reduce the uncertainty of data through analytical quality control. In particular, a recently completed project on assessment of human exposure to lead and cadmium through biological monitoring would be of immediate relevance to the evaluation of seafood consumption as well as being of general interest.
- 12.2 When discussing chemical analysis in relation to marine pollution, the Group confirmed that similar problems of data validity and comparability exist in many areas and scientists are aware of it. The Group noted that at some stage GESAMP may have to look more closely at questions related to quality control.
- 12.3 The Group took note of information provided on the International Symposium on Integrated Global Ocean Monitoring which was being planned for Tallin, USSR, from 2 to 10 October 1983.
- 12.4 Noting that the GESAMP Guidelines for Procedure prescribe that the Technical Secretaries should prepare a brief information paper summarizing the activities of their organizations for each session, the Group was informed that the United Nations Cross-Organizational Programme Analysis (COPA) of Marine Affairs Activities of the United Nations System contained already a relevant summary and that the preparation of the summaries referred to above was to some extent superfluous. The Group noted that the relevant paragraph would be deleted from the Guidelines for Procedure and expressed appreciation to the Technical Secretaries for their previous contributions to GESAMP in this regard.

13. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN FOR THE NEXT INTERSESSIONAL PERIOD AND FOR THE FOURTEENTH SESSION

- 13.1 The Group unanimously elected Mr A.D. McIntyre as Chairman and Mr E.D. Gomez as Vice-Chairman for the next intersessional period and for the fourteenth session of GESAMP.

14. CONSIDERATION AND APPROVAL OF THE REPORT OF THE MEETING

- 14.1 The report of the thirteenth session of GESAMP was considered and approved by the Group on the final day of the session. The Group expressed its appreciation to Mr A.D. McIntyre for the effective way in which he had guided the work of the session.



ANNEX I

AGENDA

- Opening of the meeting
- 1 Adoption of the Agenda
- 2 Review of the health of the oceans
- 3 Oceanographic model for the dispersion of wastes disposed of in the deep sea
- 4 Review of potentially harmful substances
- 5 Evaluation of the hazards of harmful substances carried by ships
- 6 Interchange of pollutants between the atmosphere and the oceans
- 7 Biological effects of thermal discharges in the marine environment
- 8 Review of the GESAMP definition of "marine pollution"
- 9 Marine pollution implications of ocean energy development
- 10 Future work programme
- 11 Date and place of next session
- 12 Other matters
- 13 Election of Chairman and Vice-Chairman for the next intersessional period and for the fourteenth session
- 14 Consideration and approval of the report of the meeting

ANNEX II  
LIST OF DOCUMENTS

GESAMP No.	Agenda No.	Author, Source	Title
XIII/1	1	Administrative Secretary	Provisional Agenda for the Thirteenth Session of GESAMP
XIII/2	2	Steering Committee	Review of the Health of the Oceans - Proposed Future Work
XIII/3	3	Working Group	Draft Report of the GESAMP Working Group on an Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea
XIII/4	4	Working Group	Report of the First Session of the GESAMP Working Group on Review of Potentially Harmful Substances
XIII/5	5	Working Group	Evaluation of the Hazards of Harmful Substances Carried by Ships - Report of the Working Group
XIII/6	6	Working Group	Report of the Fourth Session of the GESAMP Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans
XIII/7	7	Working Group	Report of the Second Session of the GESAMP Working Group on Biological Effects of Thermal Discharges in the Marine Environment
XIII/8	8	Chairman of GESAMP	Review of the GESAMP Definition of "Marine Pollution"
XIII/9	9	Working Group	Marine Pollution Implications of Ocean Energy Exploitation - Second Report of the Working Group
XIII/10	10	UNEP	Request to GESAMP for the Formulation of Guidelines for the Assessment of (a) the Waste Receiving Capacity of the Marine Environment, and (b) the Environmental Impact of Pollution on Marine and Coastal Environment

GESAMP No.	Agenda No.	Author, Source	Title
XIII/INF.1		IMO	Recent Activities of IMO in the Field of Marine Pollution
XIII/INF.2		FAO	Summary Report of Activities of FAO in the Field of Marine Pollution
XIII/INF.4		WMO	A Report on the Work of WMO in Relation to Marine Pollution since the Twelfth Session of GESAMP
XIII/INF.8		UNEP	Achievements and Planned Development of UNEP's Regional Seas Programme and Comparable Programmes Sponsored by other Bodies

ANNEX III

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ANNEX IV

REPORT OF THE STEERING COMMITTEE ON  
THE REVIEW OF THE HEALTH OF THE OCEANS

I. INTRODUCTION

At GESAMP XII proposals were made to continue the work of reviewing the health of the oceans (see GESAMP Reports and Studies No. 14, paragraph 2.6) and to discuss this matter further at GESAMP XIII, for which a Steering Committee was established.

In response, the Steering Committee wishes to propose a number of studies with the following characteristics:

- (a) each would make an individual contribution to our knowledge of the impact of injecting materials (or energy) into the marine environment;
- (b) each would serve as a resource upon which to refer and build in any future review of the health of the oceans;
- (c) taken together, they would provide continuity for a second GESAMP review of the health of the oceans to be made, and since they will be the work of some individuals who were involved in the first review, and others who were not, a corporate memory will exist for a second review to be initiated, as well as fresh insight for maintaining or changing the approach employed in the first GESAMP review.

The Steering Committee was asked in particular to produce an annotated outline of the envisaged structure of the final report and information on the method to be used in accomplishing the work. These are set out below.

II. ANNOTATED OUTLINE

Section I: Introduction

In the first Review of the Health of the Oceans a conceptual model was outlined for the ocean system, explaining essentials of the operating oceanic machine as it is presently understood. The necessity of understanding the natural system and its fluctuations in order to establish non-natural changes were stressed. In the introductory section of a second review, reference should be made to this. However, examples should also be presented explaining or demonstrating consequences of a breakdown of the natural system and an attempt be made to determine the biological stress/response and residence times for selected classes of contaminants in the marine environment. Use should be made of selected case studies if these highlight regional variability or special problem areas where the operative processes may be best described by limiting the boundary conditions.

Section II: The transport of matter across the main boundaries

A brief outline should be given of the basic concepts involved. Following this the inputs and fluxes of selected substances across the major interfaces should be discussed in the context of the health of the ocean so that a composite mass balance can be constructed and a capability for predicting the consequences of changes of rates of inputs and fluxes.

Section III: The temporal aspects of selected classes of environmental contaminants

An evaluation of the biogeochemical half-lives of selected classes of contaminants, taking due account of operative physical mechanisms, requires the development of strategies to model the behaviour of these contaminants from source to sink. This demands that

attention be paid to the various sources, their properties (e.g. reactivity, biodegradability, oxidisability etc.), and the characteristics of the environment (e.g. circulation, temperature, salinity, biological activity, mineralogy etc.). The residence times determined from such models may also be fruitfully employed to estimate the receiving capacity of a marine ecosystem for a particular pollutant, employing a predictive model. The classes of compounds selected may, in addition to the substances considered by GESAMP to be pollutants, include natural analogues, if these better serve to illustrate pathways or deviations from the "pristine" environment.

#### Section IV: Exposure/response relationships

An evaluation should be made of the response of biota to exposure to environmental pollutants, both individual compounds and complex arrays such as composite industrial or human effluents, through provision of quantitative dose-response functions. Species and biochemical indicator mechanisms with identifiable short-to-medium and long-term response characteristics could be selected and evaluated. The information from regional case studies where specific changes of the biota have been recorded and linked to environmental contamination could be assessed and used in this development (e.g. the occurrence of dinoflagellate blooms, plankton bloom proliferation following eutrophication etc.).

#### Section V: Large scale processes in the marine environment

There are a number of large scale oceanic processes which have natural variability with time scales of decades (e.g. natural temperature variations of 2-4°C which may have caused the disappearance or appearance of important fisheries; or possible changes of oceanic redox potential in some areas). Additionally, there are human activities which can potentially influence such changes or trends (e.g. the mobilization of CO<sub>2</sub>). These require identifying and assessing within the context of stress/response relationships, once again giving due consideration to the understanding of the operative mechanisms involved in the various processes.

#### Section VI: The diagnosis of the state of the global oceans; identifiable trends and consequences of man's impact

It may be appropriate to continue the development of methodology for assessment, building upon what was in the first review, with extensions made to consider the recent experiences gained during the course of the exercise. This may also be expanded to include strategies for selection between options for waste disposal; for instance in relation to the circulation and exchange between the various compartments of the environment.

The problems associated with establishing trends should be defined and discussed. These include the division between natural and non-natural fluctuations, time series observations, time scale, intercomparability of data and methods. Criteria for data to be used in trend analysis should be established. Thereafter, an attempt should be made to use data known to have been generated from programmes with strict data quality control in order to evaluate changes and, if possible, establish trends. Coordinated monitoring programmes, input studies and long term studies by one laboratory in a given region could feasibly be employed.

Clear divisions should be made in assessing trends according to their scale (global, regional, local) or according to the habitat considered (mangrove, coral reefs, lagoons, wetlands, etc.).

#### Section VII: The requirements for environmental management of the marine environment

## Section VIII: Summary

The above discussion is expanded in the Appendix where specifics of each chapter are identified.

### III. APPROACH TO ACCOMPLISHING THE TASK

The work may be undertaken in three phases as follows:

#### Phase I: Preparatory phase and critical evaluation of data (tentatively 1983-85)

Existing GESAMP working groups should be used insofar as possible, with new working groups formed as required for other components not covered. These working groups, under the guidance of elected chairmen, should meet at suitable intervals, possibly in connexion with conferences and should also work by correspondence. Each working group should aim towards producing individual reports to be published as GESAMP Reports and Studies.

#### Phase II: Integrating the material (tentatively 1986-87)

When appropriate, GESAMP should create a working group of suitable size to assimilate the information assembled in the preliminary phase, and produce a report that would constitute the draft of the next Review of the Health of the Oceans.

#### Phase III: Producing the report (tentatively 1987-88)

The concluding step will be the final writing and publishing of the review, preferably done by a group consisting of scientists from each of the working groups involved in phases I and II.

### IV. DISCUSSION

It was agreed that the following components had high priority, and were of such a nature that they should be initiated now, so as to provide input for the second review.

#### 1. Transport and fluxes of selected substances across the main boundaries

The air/sea interface would be considered by the existing Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans; the land/sea and sediment/water interface would be considered by a newly established Working Group on the Land-Sea Boundary Flux of Pollutants. These working groups would also specifically consider trends in inputs and the source functions of the selected substances.

#### 2. The investigation of trends or changes

This includes consideration of the sources, the conditions existing in the environment and trends in developments. Trends or changes in the environment may be generated by natural processes (e.g. climatically induced) or be caused by human influence (e.g. by the input of contaminants and through human exploitation of living resources). These factors need to be taken into account in an assessment of trends and changes. Trends should also be considered in man's activities, in development of new technology and uses of the environment as well as in knowledge, which will advance our understanding.

Trends as regards inputs could be treated by the above-mentioned working groups. Examples of trends in technological developments are given in the report of the Working Group on the Marine Pollution Implications of Ocean Energy Development and could be developed in the framework of the newly established Working Group on

Methodology and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment. Trends in developments of the coastal zone and in man's uses of this part of the marine environment might well be part of an updating of the earlier GESAMP work on coastal water quality criteria, and it is suggested that this be considered later by GESAMP. Other trends would perhaps best be investigated by the use of selected case studies. Thus it may also be possible to establish criteria for recognizing "ill health" and factors which need to be included in assessment programmes. It was felt that terms of reference for a new working group on these matters may be developed intersessionally.

### 3. Development of assessment methodology and dose/response considerations

The quantification of dose/response functions, considerations of mechanisms and the use of results from new techniques in studies of biological effects could form a natural part of the Working Group on Methodology and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment. These components were considered essential building blocks for any future Review of the Health of the Oceans.

### 4. Hazard evaluation of selected substances

The results of the GESAMP Working Group on the Review of Potentially Harmful Substances should be used as appropriate in the elaboration of the second Review of the Health of the Oceans, in accordance with the work programme outlined at GESAMP XIII for that working group.

The Group also noted that it would be relevant for the next Review of the Health of the Oceans to consider aspects of the first GESAMP review and therefore suggested that this should be incorporated in the terms of reference as:

"(iii) To consider new information in the light of the first GESAMP Review of the Health of the Oceans, and the suggestions made therein, and update as required."

## APPENDIX

It should be noted that the details outlined hereunder are to be considered only as one way to accomplish detailing the suggested topical areas. GESAMP working groups taking these matters under consideration should be given maximum latitude in altering this approach as they see fit.

### Section I: Introduction

The marine environment as a dynamic system and its boundaries, including for example:

- (i) factors influencing the transport, interchange, transformation and cycling of components;
- (ii) the atmosphere/ocean, land/sea, seawater/sediment boundaries;
- (iii) the internal circulation

### Section II: The transport of matter across the main boundaries

- (i) introduction, basic concepts (with reference to Section I);
- (ii) the atmosphere/ocean interface, fluxes of selected compounds and tables of fluxes;

- (iii) The land/sea interface, river impacts and fluxes (particulate, dissolved) of selected compounds;
- (iv) the seawater/sediment interface, disposition, remobilization rates of selected substances

Section III: The temporal aspects of selected classes of environmental contaminants

- (i) the cycling time for selected substances (half life), including
  - influence of physical, chemical, biological processes;
  - tables of residence times for selected pollutants;
- (ii) the assimilative capacity of an ecosystem for pollutants, including
  - conceptual modelling;
  - mathematical modelling;
  - the methodology for assessment of the receiving capacity.

Section IV: Exposure/response relationships

- (i) the concept of exposure/effects and exposure/response relationships, including quantifications for:
  - the ecosystem (concentration related to compounds);
  - biota;
- (ii) marine toxicology, including
  - the dose/response relationships;
  - the "damage" curve;
  - the detoxification enzymes as indicators of sublethal contacts with compounds that stimulate or inhibit those enzymes.

Section V: Large scale processes in the marine environment

Trends of selected characteristics in selected areas as case studies.

Section VI: The diagnosis of the state of the global ocean; identifiable trends and consequences of man's impact

- (i) assessment of methodology;
- (ii) assessment of changes in sources of contamination;
- (iii) evaluation of trends in the distribution and concentration of contaminants;
- (iv) assessment of technical developments (technology of analysis, advances in concepts);
- (v) assessment of global, regional and local trends;
- (vi) assessment of special habitats.

Section VII: The requirements for environmental management of the marine environment

- (i) local scale;
- (ii) regional scale;
- (iii) global scale;
- (iv) the state and trends in marine resources under the existing and projected pollution loads with reference to:
  - fisheries and living resources including mari-culture;
  - minerals and non-living resources;
  - amenities.

Section VIII: Summary

ANNEX V

SUMMARY OF THE REPORT OF THE WORKING GROUP ON AN  
OCEANOGRAPHIC MODEL FOR THE DISPERSION OF WASTES  
DISPOSED OF IN THE DEEP SEA

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1. In summarizing the content of the report, the Chairman of the Working Group pointed out that Chapter 1 described the points which influenced the Working Group. Those which should be pointed out are:
  - (i) there is no reason to use complicated models when simple ones will do;
  - (ii) in complicated situations like the deep ocean, reasonable estimates require a well-defined problem;
  - (iii) no single detailed model could be developed and a number of models were proposed.
2. The Chairman of the Working Group indicated that in Chapter 2 the problems of parameterization were pointed out, especially since parameters varied over 17 orders of magnitude. The caution was made that models cannot be used out of context and they must be consistent with current knowledge of the ocean.
3. One of the main points in Chapter 3 is that physical processes tend to be dominant. Geochemical processes, especially scavenging, have been emphasized. Although biological processes were found to be important in terms of pathways to man, in terms of transfer of contaminants the biology carries less material than physical or geochemical processes.
4. In further chapters there is a description of existing and potential models, a listing of the most important processes to be considered when a model is selected, and a discussion of model sensitivity and reliability. Further research needs were also mentioned.
5. It was pointed out by the Chairman of the Working Group that the appendices were of two types. The first ones provide summary reviews of information not currently available and the second ones calculations using models developed by the Working Group. These appendices were described with notation of where some technical and editorial work was needed of value.



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FOR THE DISPERSION OF WASTES DISPOSED OF IN THE DEEP SEA

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- 2.3 Near Field and Far Field Models
- 2.4 Expectation and Fluctuations
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  - 4.2.1 General
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- 5.2 Definition of Domains
- 5.3 General Results Affecting Model Selection
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- A2            Natural History of the Ocean
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- A10          Estimation of Concentrations in Food Chains

References

Glossary

List of Symbols

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ANNEX VI

SUMMARY OF THE REPORT OF THE WORKING GROUP  
ON THE REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

1. At GESAMP XII the Working Group was reconstituted and its role within the overall programme of GESAMP defined. Its main function was to evaluate marine pollutants on a substance-by-substance basis thus providing a direct input to the second Review of the Health of the Oceans. According to its terms of reference the task of the Working Group was two-fold:
  - (i) to prepare short referenced reviews on selected substances; and
  - (ii) to produce a scientific evaluation of their harmful effects.
2. At GESAMP XII it was agreed that during the intersessional period three substances should be considered: cadmium, lead and tin. Thereafter reviews were envisaged for arsenic, mercury, toxaphenes, phthalates, organosilicons, chlorinated and brominated aromatics, PNAHs and nutrients (phosphorus, etc.).
3. The methods and approaches to be applied by the Working Group were discussed and agreed upon at a planning session in Stockholm, 24-25 September 1982 which was attended by the Chairmen of GESAMP and the Working Group, and by the agency representatives. Starting from the IRPTC data profiles, the WHO environmental health criteria documents, and the already undertaken critical reviews of published data and other secondary literature, a critical examination of the reliability of references was considered necessary.
4. The first session of the Working Group was convened at WHO, Geneva, from 31 January to 4 February 1983. Draft reports on the hazard profiles of cadmium, lead and tin were available as working documentation. In addition, a background paper relating to dietary intake questions had been prepared.
5. Following the review of the draft reports, the meeting prepared an evaluation of each substance. This evaluation was done in two parts, i.e. one dealing with potential harm to marine living resources, and one dealing with potential health hazards. For the latter evaluation, the provisional tolerable intake figures issued by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) were taken into consideration. In some cases, the data based on human health aspects and on dietary intake due to seafood consumption were rather inadequate to support a final evaluation.
6. As concerns the first group of substances (cadmium, lead and tin), the present drafts would be ready for revision and final review at the second session of the Working Group, scheduled for November 1983. The final drafts would then be submitted to GESAMP XIV in March 1984 for approval and subsequent publication.
7. A literature study on dietary intake estimates and seafood consumption patterns will be undertaken during 1983 to be ready for discussion at the second session of the Working Group. Mediterranean research results may be incorporated thereafter and the discussion continued at the third session of the Working Group, scheduled for September 1984.
8. The Working Group agreed to take up mercury, arsenic and organosilicon compounds as the second group of selected substances. Relevant IRPTC data profiles would be available at GESAMP XIII and first draft reports prepared for review at the second

session of the Working Group. Revised drafts would be finalized at the third session of the Working Group and then submitted for approval to GESAMP XV in spring 1985.

9. The other substances selected by GESAMP XII include toxaphenes, phthalates, chlorinated and brominated aromatics, PNAHs and nutrients (phosphorus, etc.). For most of them IRPTC data profiles will be available at the second session of the Working Group. At that time their possible review by the Working Group will be discussed and a proposal submitted to GESAMP XIV. Since these items constitute rather large groups of substances the selection of the ones to be reviewed by the Working Group will have to be carefully considered.



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ANNEX VII

SUMMARY OF THE REPORT OF THE WORKING GROUP  
ON THE EVALUATION OF THE HAZARDS OF HARMFUL  
SUBSTANCES CARRIED BY SHIPS

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1. The Working Group had held its thirteenth session at Delft, Netherlands, from 25-29 October 1982 under the Chairmanship of Mr J.E. Portmann.
2. The Working Group established new hazard profiles of substances and reviewed existing hazard profiles of substances for which members of the Working Group had undertaken to carry out work during the intersessional period. The Working Group also evaluated the hazards of substances on which data had been submitted by several national maritime administrations through the International Maritime Organization to GESAMP and considered enquiries which had been made from the chemical industry on the hazard profiles of a number of substances published recently under GESAMP Reports and Studies No.17. Altogether the hazard profiles of about two hundred substances were developed or reviewed.
3. The IRPTC of UNEP informed the Working Group of its procedures used for the selection, storage and dissemination of data collected on particularly harmful substances. The Working Group felt that future co-operation with IRPTC could be very fruitful and decided to send to IRPTC a list of selected substances with a view to obtaining data, in particular on aquatic toxicity.
4. The Working Group considered the overall consistency of column A (bioaccumulation) of its hazard profiles with regard to substances rated as "liable to produce tainting of seafood" (rating T). It was realized that in the absence of a standard methodology for the assessment of tainting and in the absence of reliable data on this criteria for many substances in the literature, tainting ratings so far have been highly subjective. The Working Group agreed that for its assessment hard data should be used, such as the concentrations that give rise to tainting in a particular species. The Working Group agreed to discuss these problems at its next session on the basis of results of literature search to be carried out during the intersessional period and information on tainting methodologies which are currently used in countries of the members of the Working Group. The Working Group also requested the IMO to invite an expert in this field to participate at its next session when this item is considered.
5. In the light of the amount of work to be carried out before the entry into force of the requirements on the prevention and control of marine pollution by noxious liquid substances carried in bulk (MARPOL 73/78, Annex II) in October 1986, the Working Group requested that the possibility of increasing the frequencies of sessions be investigated.

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ANNEX VIII

SUMMARY OF THE REPORT OF THE WORKING GROUP  
ON THE INTERCHANGE OF POLLUTANTS BETWEEN  
THE ATMOSPHERE AND THE OCEANS

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1. The fourth session of the Working Group was held at the Village Girasole, Monte Carlo, Monaco, in October 1982. In following up GESAMP XII, emphasis has been put on describing atmospheric transport processes towards and into specific marine regions, using the Mediterranean as a first example.
2. From the report of the Working Group the following main conclusions and recommendations evolved:
  - (i) deposition estimates could be obtained by the application of meteorological dispersion models, which have been used successfully in other geographical areas for certain pollutants; model results have to be checked against measured concentration and deposition data;
  - (ii) in order to study the behaviour of pollutants in the atmosphere, back trajectories should be constructed on a periodic basis at the measurement stations; these back trajectories could also be used as a basis for modelling the day-to-day variations of concentrations and deposition patterns;
  - (iii) considering the difficulties connected with some of the pollutants (e.g. the presence of mercury in both vapour and particulate form) it is recommended that one pollutant should be used as a pilot substance; the Working Group is proposing to take cadmium as a first model pollutant; other pollutants could follow if the modelling of this substance proves reasonably successful;
  - (iv) special meteorological effects influencing pollutant distributions in coastal areas (e.g. land/sea breeze, sea spray effects, etc.) should be studied in the framework of this programme; the application of sophisticated and detailed meteorological models in such areas should also be encouraged.
3. While noting the importance of the present activity of the Working Group with regard to the atmospheric transport of pollutants towards and into specific regions, the Working Group stated that there were a number of present and future problems, such as physical, photochemical and microbiological processes in the air-sea boundary layer which are affected by various pollutants. It was also suggested that this Working Group could assume a predictive role toward the determination of air-sea effects of pollutants ten or more years into the future when the atmospheric transport of CO<sub>2</sub>, trace metals and other pollutants to the oceans might increase due to changing patterns of fossil fuel utilization.

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ANNEX IX

SUMMARY OF THE REPORT OF THE WORKING GROUP ON BIOLOGICAL EFFECTS OF  
THERMAL DISCHARGES IN THE MARINE ENVIRONMENT

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1. The Working Group has met on two occasions. At its first meeting (21-25 September 1981, Dubrovnik), the Working Group reviewed information on the effects of thermal discharges to coastal waters, the first of its terms of reference. At the second meeting (18-22 October 1982, Rome) this review was extended to include additional information relating to experience in tropical waters, and in biocide practices. In consideration of its second term of reference, to develop guidelines for siting, an idealized schedule and time-scale for site assessment was set out.
2. While, in temperate waters, little environmental disturbance can be seen when discharges are about 10°C above ambient, in tropical areas this temperature increment will approach or exceed the thermal tolerance limits of organisms in the receiving areas. In tropical regions, water temperatures are generally 25 to 32°C, with summer temperatures commonly about 30°C. A thermal discharge with an increment of 5°C could be damaging. At some sites, even discharges of  $\Delta T$  3-5°C have led to damage, especially where the discharge is made to shallow, enclosed areas, or across shorelines. At other sites, higher incremental temperatures have not led to damage. Information is not always available on biocide practice, which may partially explain these differences.
3. It is common practice to control macrofouling of culverts and microfouling of heat exchangers by the application of chlorine in some form. Until recently the understanding of chlorine behaviour in seawater was hampered by inability to analyse at the concentrations discharged. Within a thermal discharge it is now known that decay and dilution reduce residual concentrations so that the "chlorine plume" is within the "thermal plume", and use of the latter for prediction of effects is conservative. The toxicity and persistence of different chlorine compounds differ, and dose-effect depends on mode of operation and the chemical used, as well as on concentration, exposure time, temperature, pH, and on biomass and sensitivity of organisms.
4. With the aim of minimal environmental disturbance, assessment procedures for siting, design and plant operation have been developed, with survey and monitoring data gathered at each stage from initial site selection through to commercial operation. The Working Group, while recognizing that an ideal assessment programme might not be achieved, recommends that some assessment procedure should always be adopted. Experience of past developments can be used to help define conditions for siting and operation that will result in least environmental disturbance.
5. The Working Group has given insufficient attention to engineering, economic and planning matters, and to the effects of discharges from installations other than coastal power plants. These deficiencies could be remedied at a third meeting and a final report prepared.

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ANNEX X

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE MARINE  
POLLUTION IMPLICATIONS OF OCEAN ENERGY DEVELOPMENT

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1. The report is a result of two intersessional meetings held at Unesco Headquarters in Paris from 29 June to 2 July 1981 and at FAO Headquarters in Rome from 25 to 29 October 1982.
2. The terms of reference of the Working Group were those set out at the Eleventh Session of GESAMP:
  - (i) to review the current literature and results of ongoing research and describe marine pollution implications of the exploitation of the major sources of unconventional ocean energy with special reference to coastal areas and multiple-use concepts, particularly in developing countries;
  - (ii) to discuss long-term environmental impacts to be expected from extensive oceans energy exploitation at the global level.
3. The Working Group concentrated its efforts on ocean thermal energy conversion (OTEC) considered by the Ocean Energy Technical Panel of the UN Conference on New and Renewable Sources of Energy (UNERG) to be the most promising form of ocean energy holding the greatest long-term potential for developing countries. Other energy sources considered were wave energy, tidal energy, and energy from marine biomass.
4. In the absence of commercially operational OTEC plants current evaluations are based on anticipated impacts of OTEC plant operations. OTEC programmes are being undertaken by the United States, Japan, France, the Netherlands, Jamaica and Sweden for sites in tropical areas. It is expected that first generation plants, and the majority of those in developing countries, will be under 100 MWe and may be land-based or shelf-mounted rather than moored or floating in deeper water.
5. The OTEC examination was initiated using a working paper prepared by leading scientists in the United States OTEC environmental programme. A small Working Group was organized in 1981 which included scientists and engineers from France, the Netherlands and the US who reviewed this paper and supplied additional information from projects within their own experience.
6. The review of other ocean energy sources was based on less information and study although tidal energy is the only form which is being commercially exploited today at La Rance, France.
7. Environmental concerns for OTEC divided into near-term matters related to local coastal impacts and long-term matters associated with increased number of large plants having impacts on a regional or global basis.
8. A variety of studies and surveys are needed at potential ocean energy sites to ensure that the plans are scientifically and environmentally sound. These studies fall into two major categories:
  - (i) those associated with the engineering and construction of a practical plant;
  - (ii) those associated with operating the plant and utilizing its products including upwelled waters.

9. It was generally recognised that adverse environmental impacts can occur in the construction and operational phases of ocean energy plants but that the risks can be reduced to acceptable levels through proper planning and design.

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